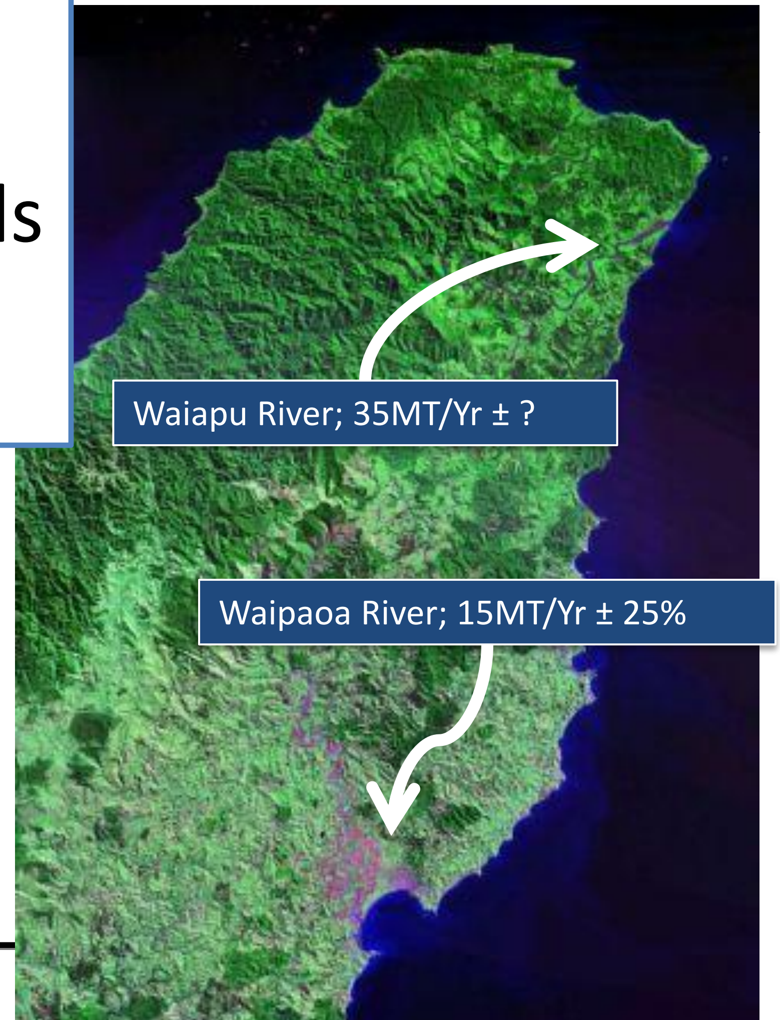
Sediment Dispersal Offshore Of Small Mountainous Rivers: Insights from Numerical Models

From source to sink: triggers on the inner shelf?



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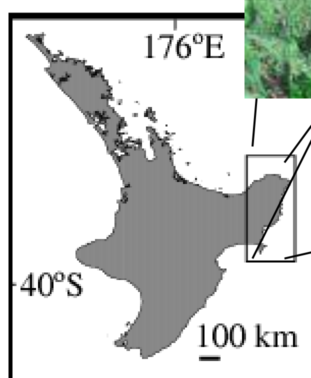
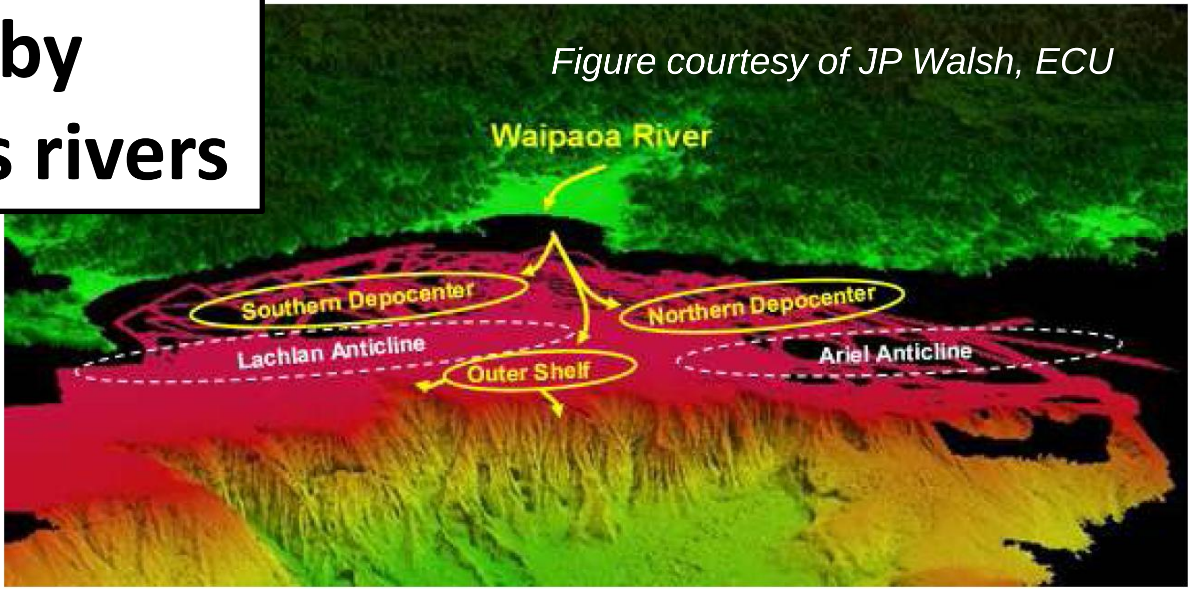


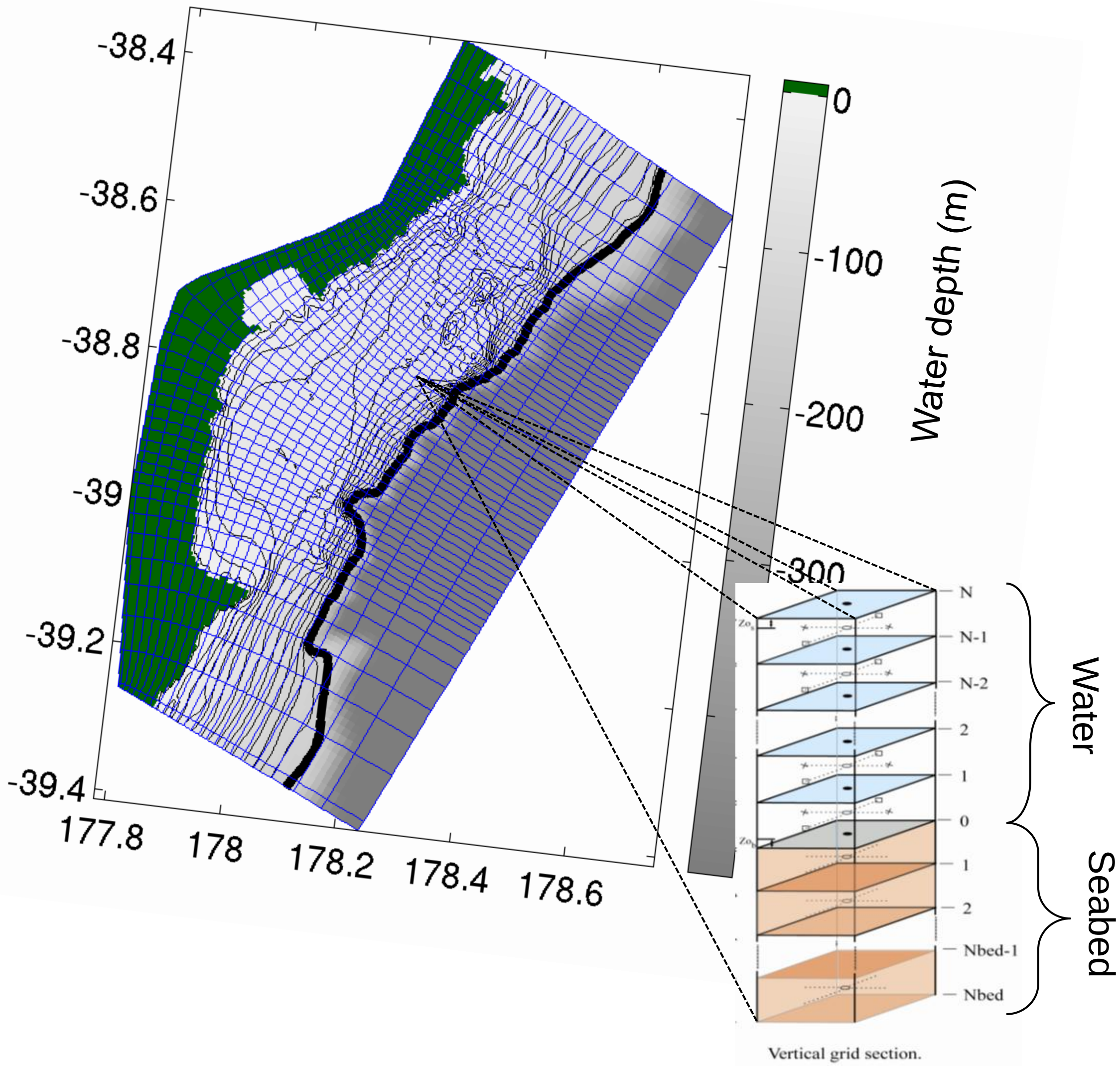
Sediment delivery by small mountainous rivers



- High sediment yields.
- River mouth often exposed to oceanographic forces.
- Flood plume might carry sediment directly to mid-shelf depocenters (non-stop delivery).
- Sediment delivery during significant events may overwhelm inner shelf: cross-shelf flux seems limited.
- Sediment trapped, deposited, or somehow remains on inner shelf.
- Eventually something triggers cross-shelf flux (gravity flow induced by waves or currents).

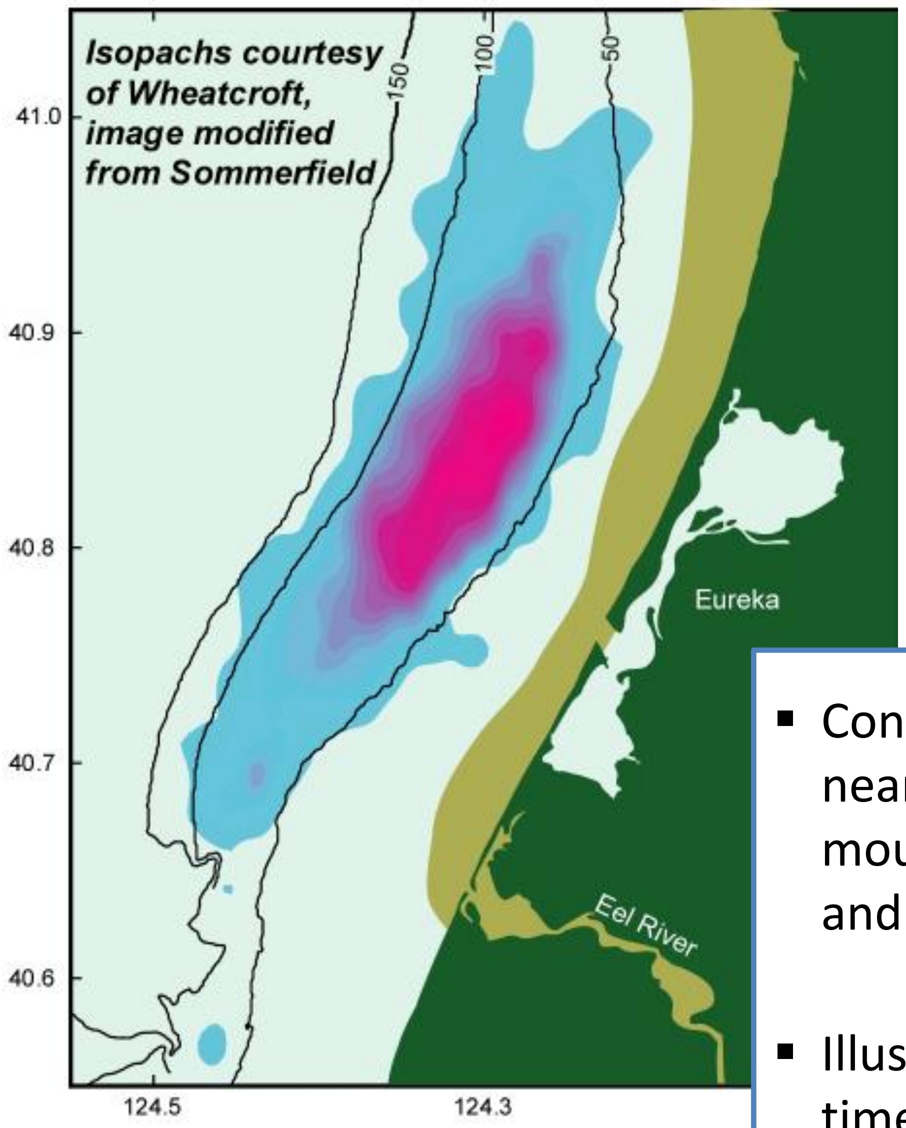
Sediment Transport Model

- Approach:
  - Three-dimensional.
  - Include water column and sediment bed.
  - Coupled sediment transport and physical oceanographic models.
- Account for:
  - Waves and currents.
  - Suspended transport.
  - Bed armoring.
  - Fluvial input.
  - Gravity flows (*).



Grid for ROMS – SWAN Waipaoa shelf model under development by J. Moriarty (VIMS)

OBJECTIVES

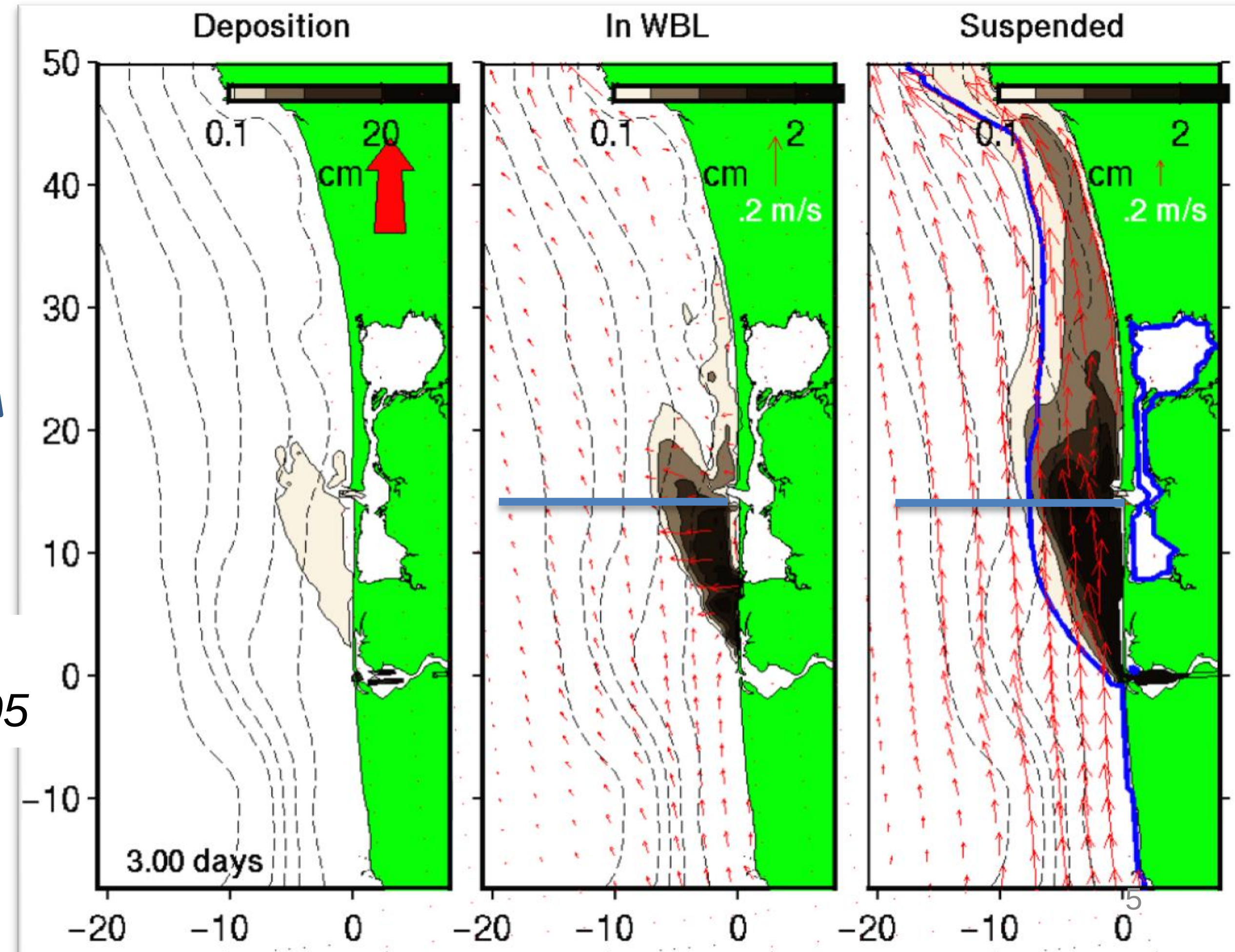


- Contrast delivery mechanisms for the nearshore and inner shelf of three small mountainous river systems (the Eel, Waipapu, and Waipaoa Rivers).
- Illustrate capabilities of event- to seasonal-timescale three-dimensional numerical models for evaluating sediment dispersal within the coastal zone of continental margins.

Eel River shelf

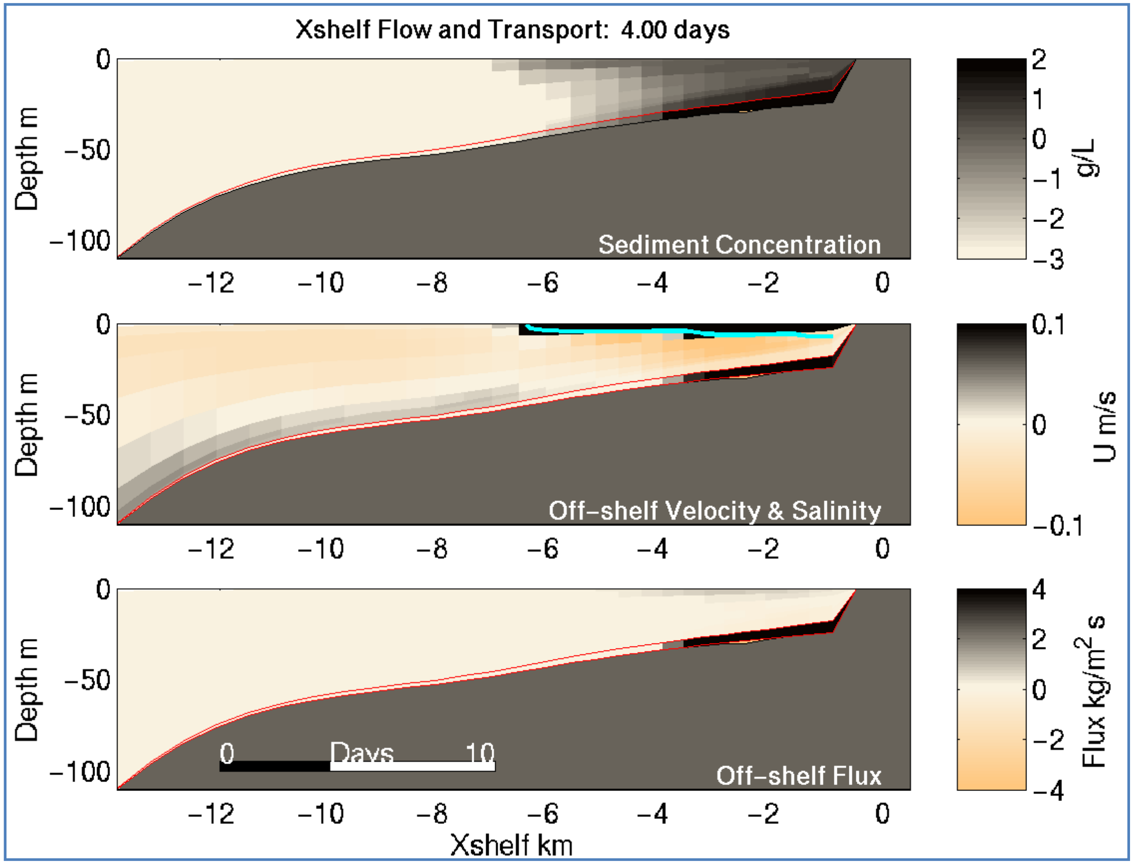
- Muddy deposits on mid-shelf.
- Flood plume delivers sediment to inner shelf.
- Wave supported gravity flows deliver material to mid-shelf.

- Plan view of model



Harris et al. 2004, 2005

Cross-shelf flux offshore of Eel River



Harris et al. 2004, 2005.

- Sediment delivery to mid-shelf determined by wave energy.
- Thickness of mid-shelf flood deposits function of wave energy.

Waiapu River mid-shelf deposit

- ^{210}Pb from Kniskern et al. 2010.
- Inner shelf storage (Wadman and McNinch, 2008).
- Accumulation rates peak ~80 m isobath.
- Cross-shelf transport mechanisms?

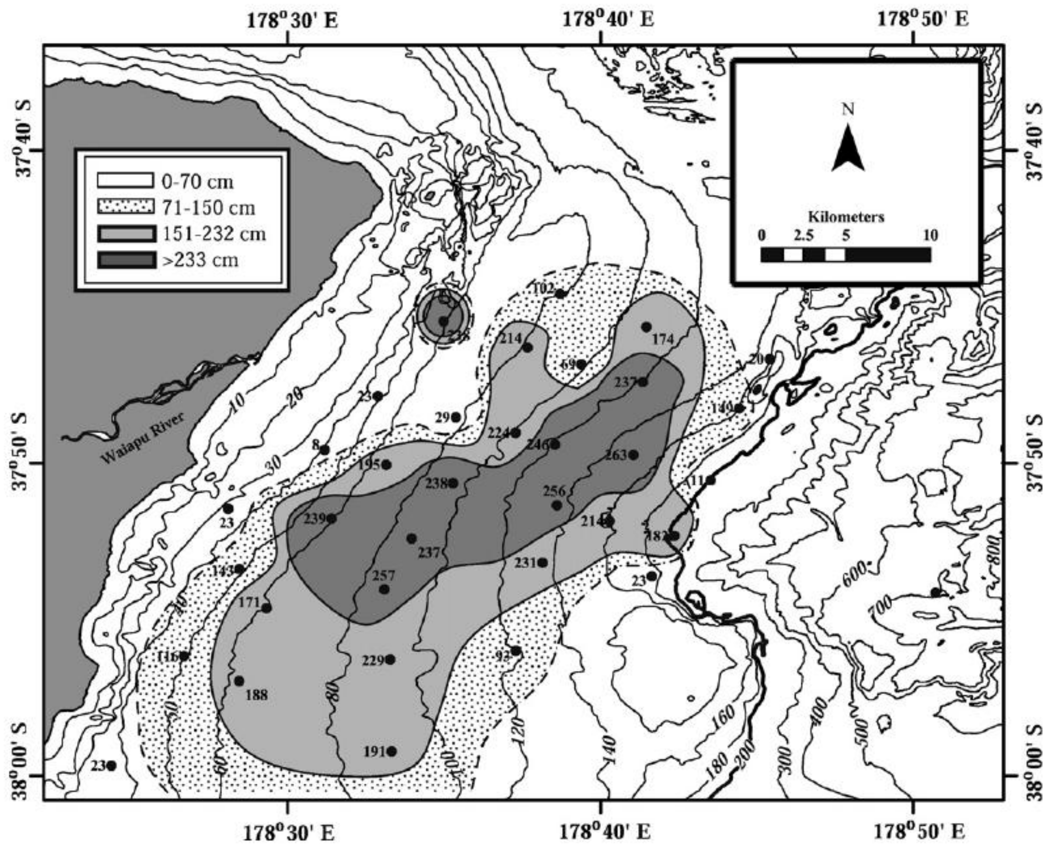


Figure from Kniskern et al. 2010

Wave supported gravity flows carry sediment to mid-shelf

- Wave – supported gravity flows: Model estimated flux to 30 – 40 m isobath (Kniskern, 2008).

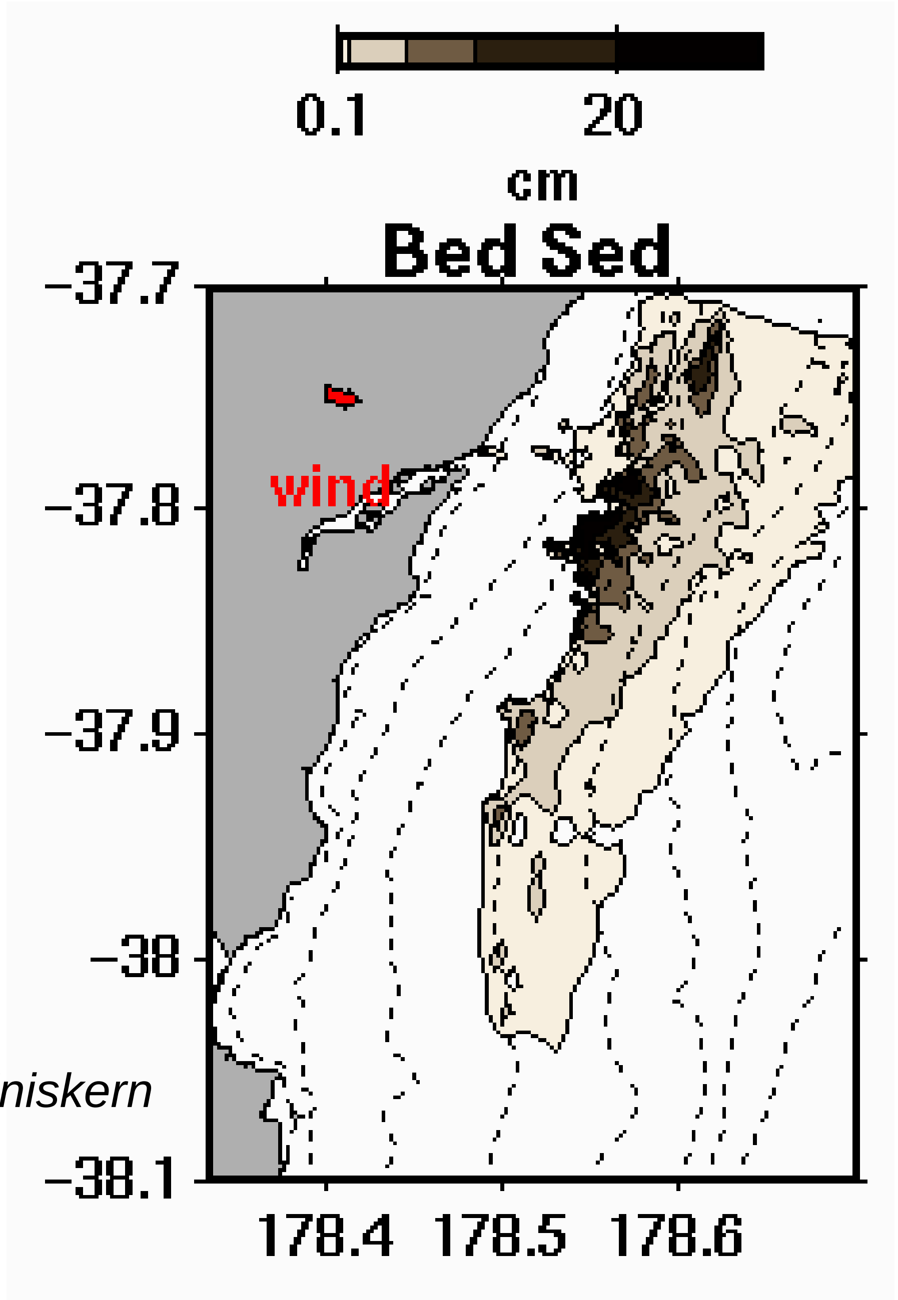


Figure from T. Kniskern

Waiapu River Shelf

- Tripods deployed at 40 and 60 m water depth.
- Current supported gravity flows carry sediment across-shelf (Ma et al. 2008).
- Post-flood turbidity triggered by cross-shelf currents.

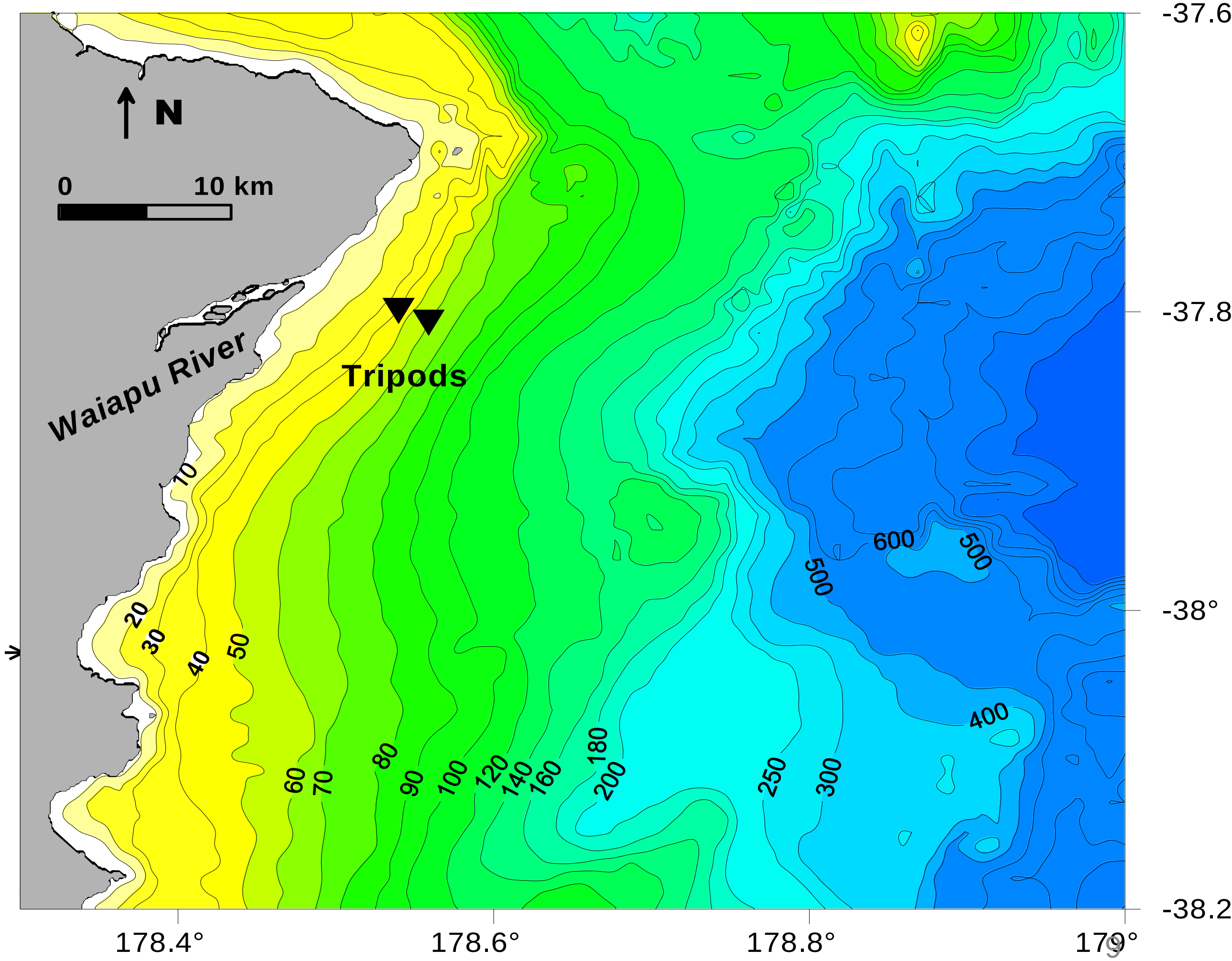
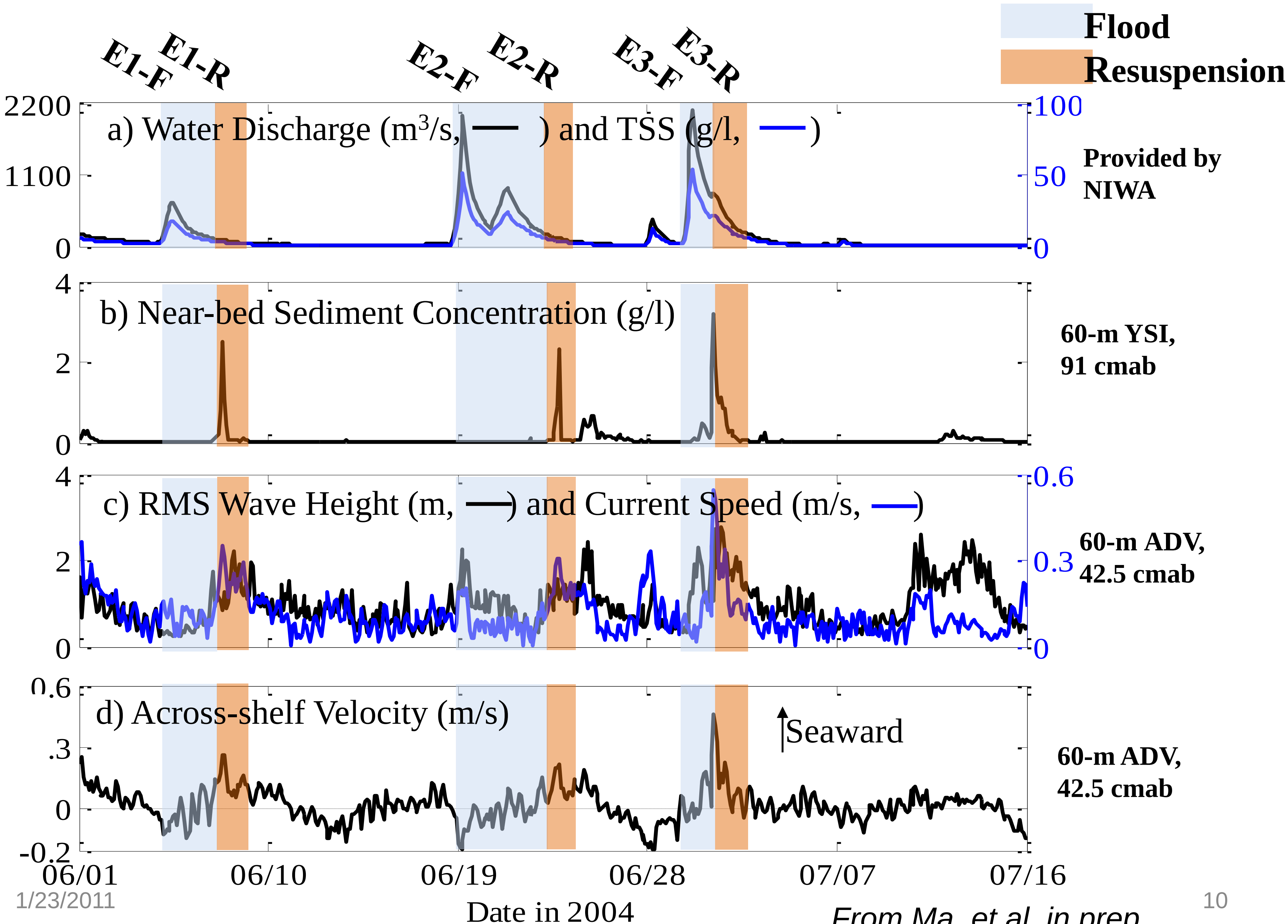


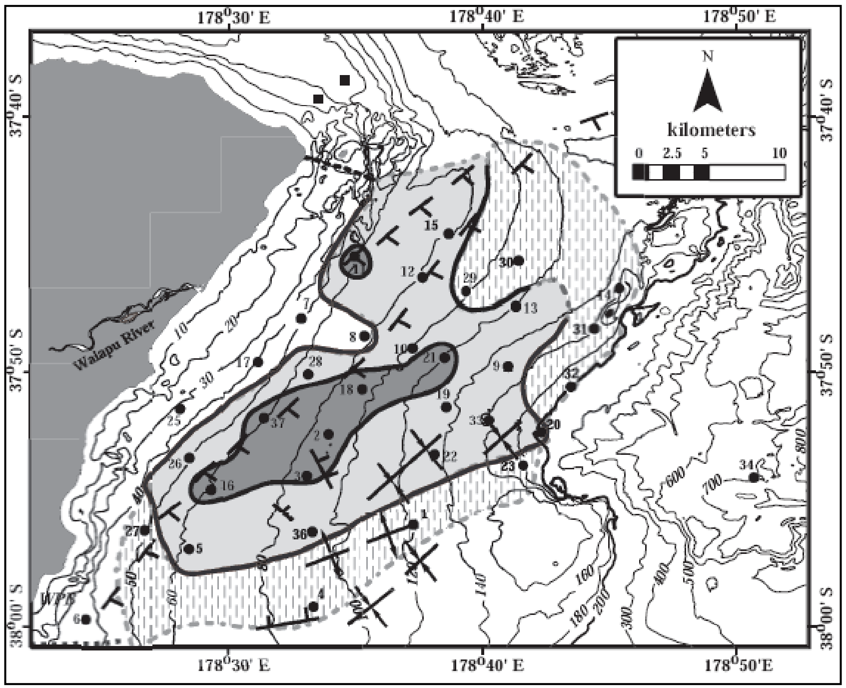
Figure from Y. Ma

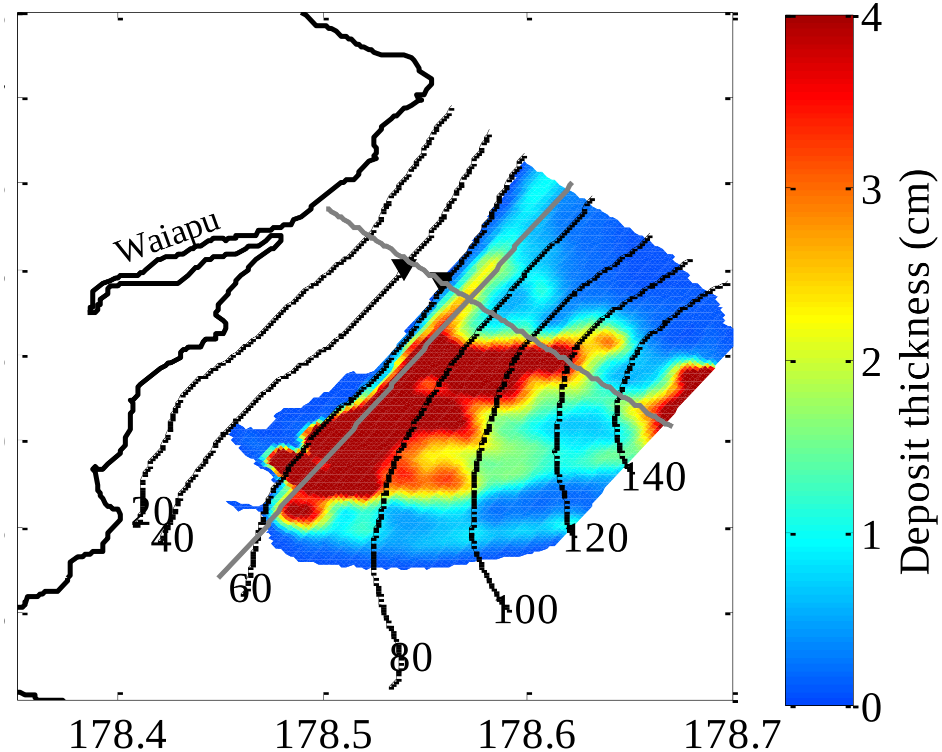
Cross-shelf flux: strong waves and seaward currents



From Ma, et al. in prep.

Current supported gravity flows move sediment offshore to 80 m isobath.



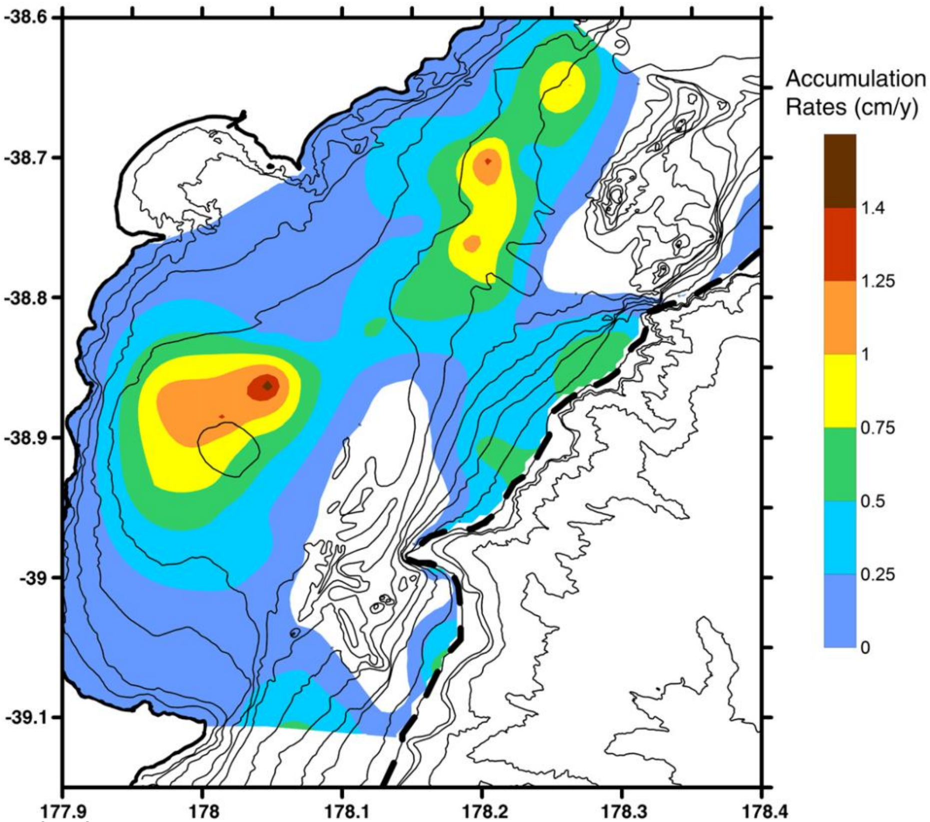


From Ma et al. 2010.

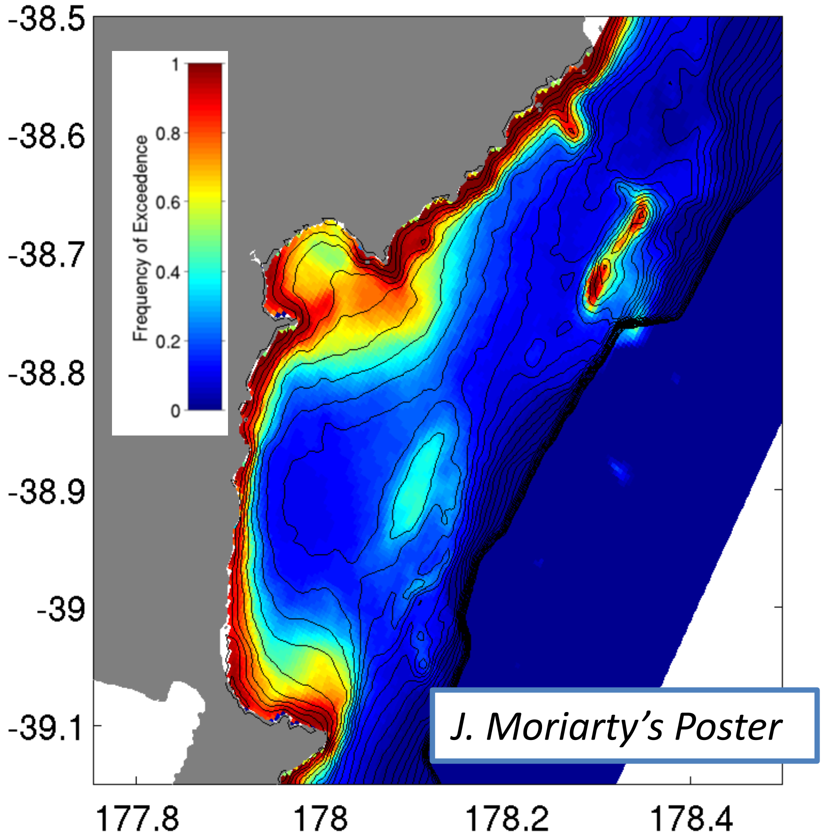
Waipaoa River shelf

- Sediment delivered to Poverty Bay.
- Bed stresses relatively low in Poverty Bay.

Miller and Kuehl, 2010

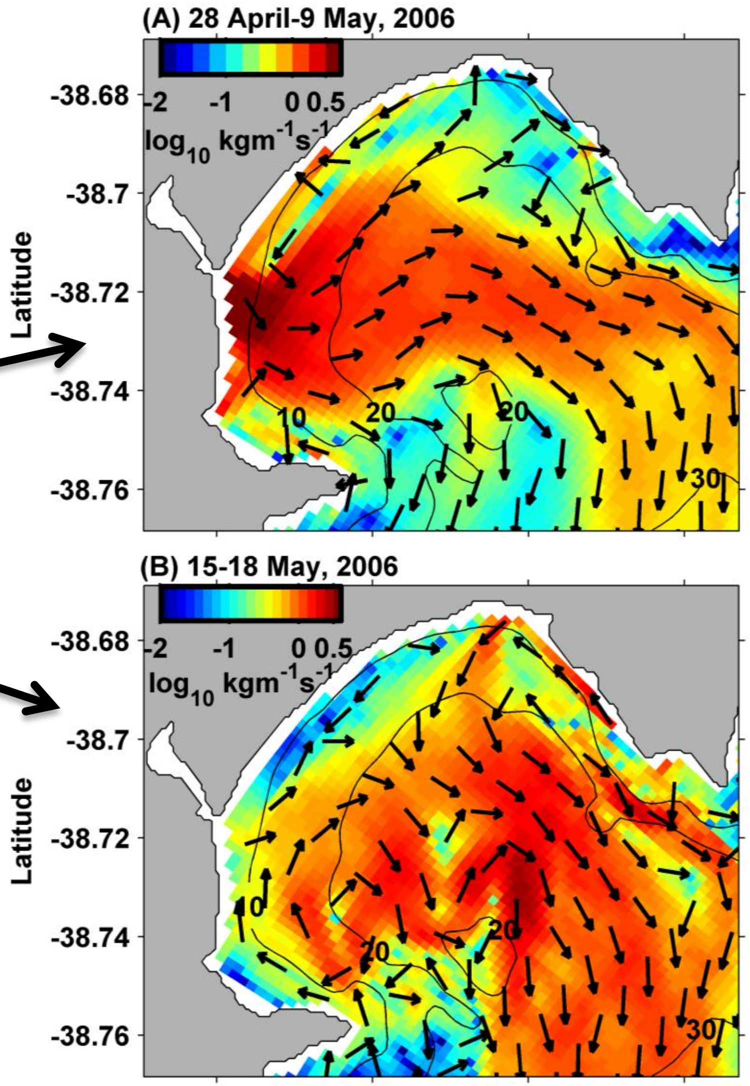


Frequencey of Exceedence: $\tau_{cw,\,max} > 0.1$ Pa

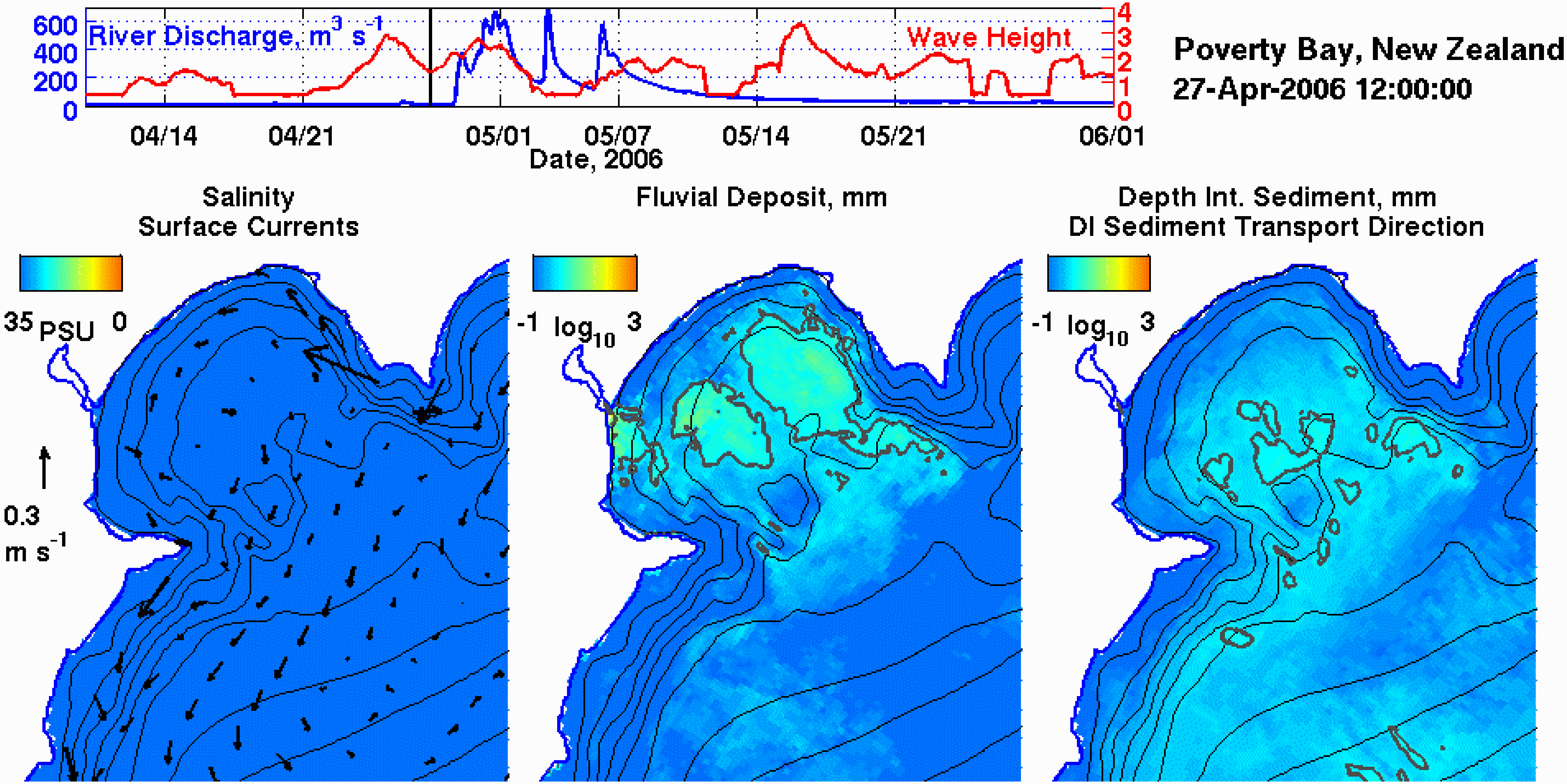


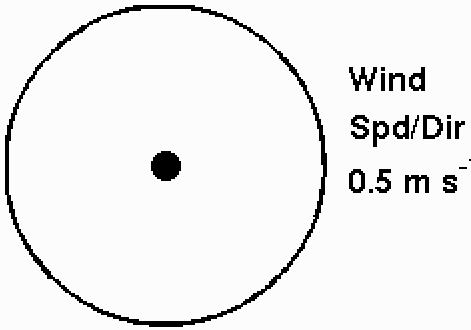
Sediment export during flood pulse, and wave resuspension

- ROMS model estimates of suspended sediment flux.
- Top panel: Non-stop to the shelf during flood pulse.
- Bottom panel: Later export to mid-shelf, triggered by energetic swell waves. about one week after floods.



From Bever dissertation (2010), in prep. as Bever and Harris.





Bever and Harris, In Prep

- Three systems considered: each had different triggers for sediment delivery to shelf.

- Coherence does not guarantee delivery, dispersal, and deposition to be in phase.

- Shallow coastal areas act to modulate sedimentary signals on continental margins.

- Currents, as well as waves and fluvial load, can create gravity flows on continental shelves, thereby triggering cross-shelf flux.

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